FACTORS CONTRIBUTING TO PANEL DEFECTS AND THEIR CORRELATION IN COLOUR PICTURE TUBE MANUFACTURING

BY

LIM SUI TAR

OPEN UNIVERSITY MALAYSIA

FACTORS CONTRIBUTING TO PANEL DEFECTS AND THEIR CORRELATION IN COLOUR PICTURE TUBE MANUFACTURING

BY

LIM SUI TAR

Project Paper Submitted in Partial Fulfilment of the Requirements for the

Degree of Master of Information Technology

Open University Malaysia
(2006)

ABSTRACT

(English)

This project is to determine the factors, which can contribute to defect in manufacturing TV panels such as phosphor stripe size, phosphor peel off and phosphor contamination. The correlation of each factor versus panel defects in the Phosphor Coating process was investigated. The study was carried out by collecting experimental data in the colour picture tube manufacturing environment. The statistical analysis was performed by using 6-sigma methodology, together with Minitab software.

ABSTRAK

(Bahasa Melayu)

Projek ini bertujuan untuk mengkaji faktor-faktor yang menyumbang kepada berlakunya kecacatan dalam penghasilan panel TV seperti *phosphor stripe size, phosphor peel off* dan *phosphor* contamination. Selain itu, kajian juga dilakukan untuk mengetahui hubung kait setiap faktor terhadap kecacatan yang dihasilkan. Kajian ini dilakukan dengan mengambil data-data yang dihasilkan daripada uji kaji yang berkaitan. Analisis data dilakukan dengan penggunaan program *Minitab* dan metodologi *6-sigma.*

ACKNOWLEDGEMENTS

I would like to take this opportunity to extend my heartfelt gratitude to my supervisor, **Prof Dr. Kasiran Buang** for his advice, guidance, patience, encouragement and knowledge in completing my final year project. It is an honour to work under his supervision as I had the opportunity to gain useful knowledge and good academic exposure. I would like to thank **Mr. Sam Lee,** a 6 sigma Black Belt Engineer as my advisor in analysis and design of experiment (DOE).

DECLARATION

Name : LIM SUI TAR
Matric Number : CGS00017703

I hereby declare that this project paper is the result of my own work, except for quotations and summaries, which have been duly acknowledged.

Signature: _____ Date: 20/11/06

TABLE OF CONTENTS

Page

Chapter 1: Introduction

Chapter 2: Literature Review

Chapter 3: Research Methodology

Chapter 4: Phosphors Coating

Chapter 5: Process Capability Study

Chapter 6: Process Mapping

Chapter 7: Gage R&R

Chapter 8: Correlation Study

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS/GLOSSARY OF TERMS

FCC	Federal Communications Commission
US	United States
TV	Television
CPT	Colour Picture Tube
RGB	Red Blue Green
CMYK	Cyan, magenta, yellow and black colour
CMY	Cyan, magenta and yellow colour
CDT	Colour display tube
DI	Deionise
KPIV	Key process input variables
UV	Ultraviolet
PLC	Programmable Logic Control
R&R	Repeatability and reproducibility
KPOV	Key process output variables
CTQC	Critical To Quality Characteristics
RF	Radio frequency
V	Volt
Lx	Lux
PH	Phosphor
DOE	Design of experience
Dev	Development
μm	Micrometer

Chapter 1

Introduction

1.1 Overview

The history of TV began in 1897 when Ferdinand Braun invented the cathode ray tube. In 1907, cathode ray tube was used to produce images for the first time. The tube was an essential move in the invention of TV, followed by Philo Farnsworth and Vladimir Zworykin's independent developments of the image dissector and iconoscope respectively. By the end of the 1920s, the US had fifteen experimental stations for mechanical TV. In 1929, Herbert Hoover, the Secretary of Commerce at that time, made an appearance or debut on the mechanical TV of AT&T. RCA, the pioneer in the broadcast development, did broadcasting experiments in the early 1930s. On the eve of World War II, RCA was raising its TV standards, to ensure that it was acceptable for production. In return, the National Television System Committee, which was created by the FCC and comprised of engineers, made recommendations for having electronic TV system standard. This standard was implemented in the spring of 1941. However, World War II delayed the commercial

development of the TV even though research and development efforts targeted for the war resulted in the possibility of getting better products for the consumers. At the end of the World War II, there were less than 7,000 working TV sets, and only nine stations were available, in the entire country. The US was the leader in fabrication of TV technology, primarily because progressions were made directly before, during and after the World War II. At the same time, America's major competitors in TV development such as Germany and England halted their research programs.

The earliest TV networks in the US (NBC, CBS, ABC and Dumont) were actually part of the larger radio network systems, and many of the early TV shows were simulcast of popular radio shows. In 1951, ABC merged with United Paramount Theatres, was gaining sizable financial resources and was able to compete in a fierce TV market. Dumont was unable to survive and by 1956 was no longer viable, with ABC picking up many of Dumont's affiliate stations. Networks offered centralized sales, distribution and production services, which lowered costs for individual affiliates. This system was geared towards generating advertising revenue because advertisers were interested to reach nationwide audiences.

In the early years of TV, losses were common in the industry due to the high costs involved and the relatively low number of sets owned in the U.S. Profits grew as the market expanded and the size of the network market peaked in 1986. At

that time, competition from cable TV, Pay per View TV and VCRs began to heavily cut into market share. The big three broadcast networks had a 91% share of prime time audiences during the season of 1978/9. This situation dropped to 75% in 1986/7 and further to 61% in 1993/4.

Cable TV was developed earlier on and being used in 1950s as a way to expand the coverage of network TV in those areas that had problems receiving broadcast signals. This action taken was prompted by the desire of the market to sell TV in those areas. In 1960s, cable stations began to import alternative broadcasts into the new markets, fragmenting network coverage. The networks employed FCC regulation of the industry and this regulation had slowed down the growth of cable TV. Until 1970s, cable TV showed phenomenal growth.

(http://inventors.about.com/library/inventors/bltelevision.html)

1.2 Introduction to Colour Picture Tube (CPT)

A CPT consists mainly of a glass bulb with a picture screen at the front and an electron gun as well as a deflection coil at the back. The picture screen is coated internally with a light-sensitive (fluorescent) layer of phosphors consisting of red, green and blue stripes. The colour image is composed from these three primary colours, which can then be blended into certain combinations to produce any desirable colour.

At the back of the tube (known as the 'neck') is the electron gun containing three cathodes, each of one is for the red, green and blue signals. The cathodes are coated with a substance that emits electrons when it is heated. The beams of emitted electrons are focused by the metal parts of the electron gun, which are connected to different voltages and hence act as a lens. High-speed electrons cause the screen's phosphor coating to light up at the points bombarded by the electrons.

Inside the picture screen, approximately 10 mm from the front of the phosphor coating, a thin metal plate is placed with a pattern of small holes. This is called the 'shadow mask'. It is to ensure that the electrons from the three separate cathodes hit the correct phosphor on the screen behind the shadow mask.

All TV systems are based on the principle that an image recorded by a camera is converted into an electrical signal, which is then transmitted via a transmission channel. This in turn will be reconverted back into an image at the receiving end. At the transmitting end, a picture (split into a red, green and blue components) was recorded by a camera, which scans the picture dot by dot. The camera emits an electrical signal, the size of which at any moment is a measure of the brightness of the picture element with respect to the red, green and blue scanned at that moment. The picture is scanned in horizontal lines, from left to right, as like reading a piece of written text, then the next line down, and so on until the bottom of the picture. The transmission of moving pictures requires the repetition of this

process many times in a second. In this situation, the camera can convert the entire brightness structure of the picture into a varying electrical voltage, which is the video signal.

1.3 Context of Study

CPT tubes have three electron beams and phosphors that emit red, green, and blue light. Mixtures of red, green, and blue light can produce any colour. A colour TV appears in full colour is due to the mixing of these three coloured lights. The inside surface of a colour TV screen is coated with thousands of tiny phosphor stripes. Some of these stripes emit red light, some green light, and some blue light. The colours of a TV picture depend upon the set of these three-colour phosphor stripes. Each coloured stripe in the set is either on, off or dim. All three coloured stripes can be seen, but the pattern of an on, off or dim creates the TV pictures.

The TV directs electrons at these stripes passing through the holes in a metal mask. Three separate electron beams, coming from three slightly different angles, pass through the holes and strike the phosphors. Since each beam can only strike one colour of phosphor stripes, each beam controls the brightness of one of the three colours. A picture is produced when thousand of the stripes hit by the electron beams in a specific pattern.

1.4 Statement of Problem

In phosphor coating process several problems or defects to the CPT can occur if the process is not controlled in a proper manner. Defects such as small phosphor stripe size, oversize phosphor stripe, phosphor peel off and phosphor contamination are the major defects in phosphor coating process. Example of phosphor stripes are shows in Figure 1.1, which does not have any phosphor coating defects.

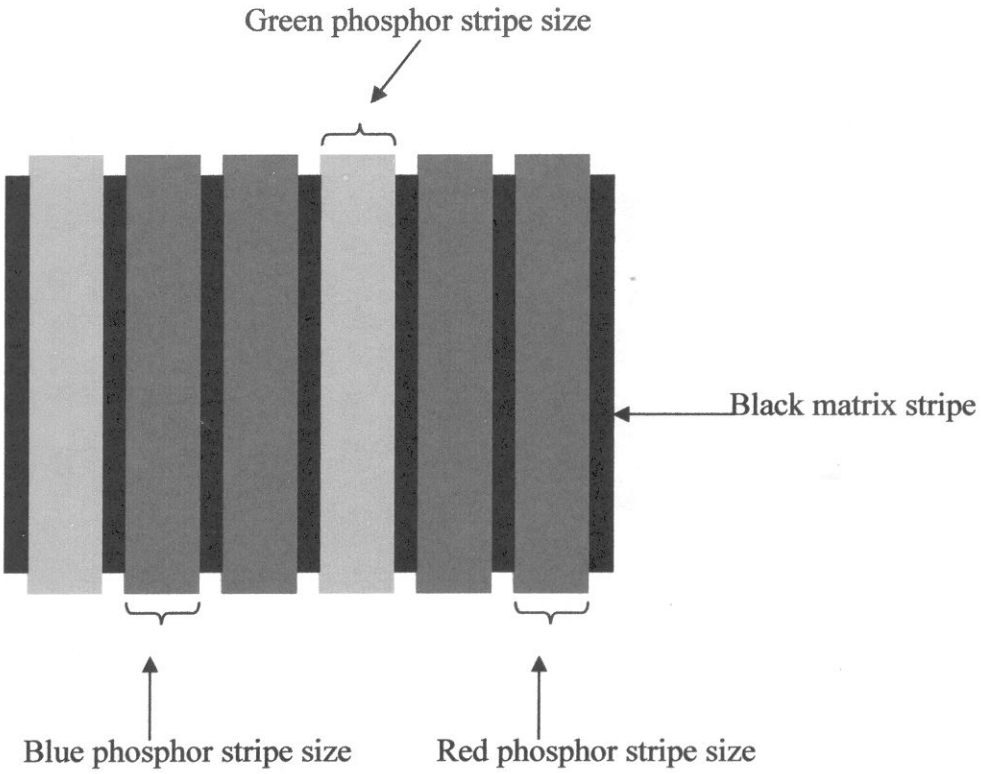

Figure 1.1: Good Phosphor Stripes

1.4.1 Oversize Phosphor Stripe

Figure 1.2 shows an oversized phosphor stripe defects which occurred in green phosphor. The green phosphor stripe has a measurement of 250 μm, where the actual required specification is only 210 ± 10μm. This defect causes colour contamination, where the green stripe overlap on black matrix stripe, red stripe and blue stripe.

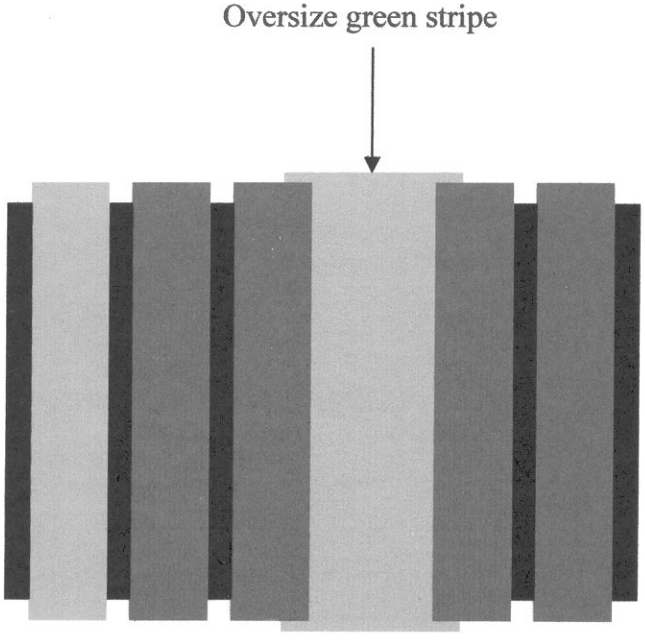

Figure 1.2: Oversize Green Stripe size (Back view)

At the front of the panel, colour contamination appears as shows in Figure 1.3, where cyan appeared at blue stripe and yellow appeared at red stripe.